Infrared Microspectroscopy of Probable Interstellar Grains in Interplanetary Dust

U10B

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GEMS (glass with embedded metal and sulfides) are 0.1-0.5 um diameter spheroidal grains with approximately chondritic major element compositions. They are an important matrix component of track-rich anhydrous interplanetary dust particles (ÎDPs) [1]. GEMS have aroused considerable interest among astronomers because their properties are consistent with those of interstellar (IS) amorphous silicate grains [2]. Amorphous silicates are ubiquitous throughout IS space and they were likely one of the major building blocks of the solar system. We are employing three approaches to further explore the relationship between GEMS and IS amorphous silicates: (a) comparison of the infrared (IR) properties of interstellar (and circumstellar) objects with those of GEMS, (b) analytical TEM studies of the mineralogy of GEMS, (c) measurement of the trace element compositions of GEMS using the synchrotron X-ray microprobe at beamline X26A. Infrared (IR) spectra from a variety of interstellar objects contain a strong feature at 10 um (and at 20 um) characteristic of silicates [4]. Although the feature varies from one source to another, it is generally broad (2.5 -3.5 um FWHM), with absorption minima between 9.25 and 10 um, and sometimes shows a weak elbow at 11.2 um [2.4]. The lack of fine structure suggests silicate glass but a minor crystalline component may be to be required to explain the elbow at 11.2 um. Observations of interstellar polarization suggest that olivine may be the crystalline component responsible for the 11.2 um elbow [5]. We have recently obtained the first IR 10 um silicate features from GEMS-rich material using a conventional globar-source FTIR system (at MVA Inc) and the high-intensity IR beamline on U10B at Brookhaven National Laboratory (BNL). The intense IR beam at BNL allowed us to record high S/N spectra from um-sized particles where we were unable to get a signal using a globar source. Samples were prepared by gently crushing IDPs between quartz slides and dispersing the fragments from each IDP onto a thin-carbon film (10 nm thick) supported on a holey-carbon TEM grid. The grids were examined using TEM and several well-isolated clusters of (2-5 um dia.) GEMS-rich material were identified. Transmission FTIR spectra were collected from these GEMS over the wavelength range 4000 - 650 cm- $\hat{1}$ (2.5 - 15.4 um). The 10 mm silicate features of four GEMS-rich clusters in two IDPs are broad (2.75-3.75 um FWHM) with absorption minima at 9.3 um. Three of the features have a distinct elbow at 11 um. There are both similarities and discrepancies between the GEMS and IS silicate features. The overall shapes of the GEMS features, their 2.75-3.75 um bandwidths, and distance between absorption minima (9.3 um) and elbow (11 um) are similar to IS silicate features, but the GEMS spectra are shifted by 0.4 um to shorter wavelengths than IS silicates [2,4,5]. It is unclear whether this reflects a real difference between GEMS and IS silicates. REFERENCES: [1] J. P. Bradley (1994) Science 265, 925. [2] S. A. and 15 Silicates. REFERENCES: [1] J. F. Bradiey (1994) Science 205, 925. [2] S. A. Sandford (1997) Met. Planet.Sci. 31, 449. [3] T. J. Bernatowicz and R. M. Walker (1997, Dec.) Phys. Today, p26. [4] D. C. Whittet and A. G. G. M. Tielens (1997) Astron. Soc. Pac. Series 122, 161. [5] D. K. Aitken et al. (1988) Mon. Not. R. Ast. Soc. 230, 629. [6] J. A. Refner et al. (1994) Synch. Rad.News 7, 30. [7] G. J. Flynn and S. R. Sutton (1992) Proc. Lunar Planet. Sci. 22, 171. [8] T. P. Snow and A. N. Witt (1996) Ap. J. 468, L65. [9] B. D. Savage and K. R. Sembach (1996) App. Pagy Astrophys. 34, 270 Ann. Rev. Astron. Astrophys. 34, 279.